Partnership for AiR Transportation Noise and Emission Reduction

*An FAA/NASA/TC-sponsored Center of Excellence*

# PARTNER

# 18 Month Progress Report

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**PARTNER Director**

**March 15, 2005: FAA Centers of Excellence Meeting**

# Outline

- *Statement of need*
- *PARTNER vision*
- *Who we are*
- *Recent accomplishments*
- *Other activities*
- *Summary*

# Statement of need

- *Aviation an engine for economic growth*
  - *3%-8% contribution to GDP*
- *Last 35 years*
  - *6x growth in mobility*
  - *ticket prices cut in half*
  - *60% reduction in energy intensity*
  - *95% reduction in people impacted by noise (55dB and 65dB)*
- *Aviation today in the U.S.*
  - *2%-3% of fossil fuel*
  - *0.25% of NOx*
  - *0.1% of CO*
  - *0.1% of VOC's*
  - *0.036% of SOx*
  - *0.005% of PM10*
  - *0.0015% of PM2.5*
- *Tremendous progress*

# Statement of need

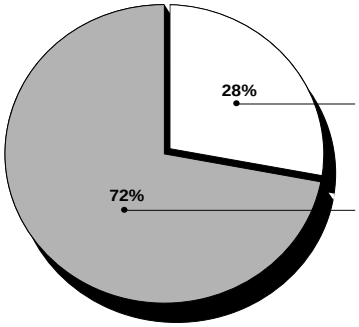
- *However,*
  - *Because of growth, emissions of some pollutants growing against a background of reductions in other sources*
  - *Local effects can be significant (e.g. airplane $NO_x$ up to 6% of county inventories in nonattainment areas)*
  - *5 million people within 55dB DNL (0.5 million w/in 65dB)*
  - *Climate effects uncertain, EU regulatory action may be coming*
  - *Potentially unique HAPS and PM issues uncertain*
- *A high leverage problem*
  - *System is capacity constrained and environmental issues are one of most significant reasons for cancellations and delays of expansion projects*

# Statement of need

- *5 of top 35 U.S. airports in need of additional capacity in 2003*
- *15 of top 35 projected to need additional capacity in 2013*
- *Assuming improvements in FAA Operational Evolution Plan (OEP) take place, otherwise 26 of top 35 airports need capacity by 2013*
- *Integrated National Plan for Next Generation Air Transportation System: 3x capacity by 2025 (more aggressive than OEP)*

*(U.S. DOT, 2004; JPDO, 2004)*

**Expansion Projects Delayed due to Environmental Issues**

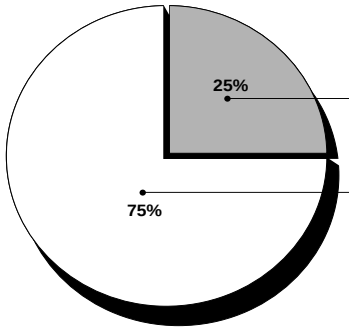



***28% (9 airports) with no impact***

***projects delayed at 72% (23 airports)***

**Source: GAO (2000) survey of 50 busiest commercial airports. N=33 for this question, 1 airport did not respond.**

**Expansion Projects Cancelled or Indefinitely Postponed due to Environmental Issues**




***25% (12 airports) with at least 1 project affected***

***no impact at 75% (36 airports)***

**Source: GAO (2000) survey of 50 busiest commercial airports. N=50 for this question, 2 airports with no projects planned.**

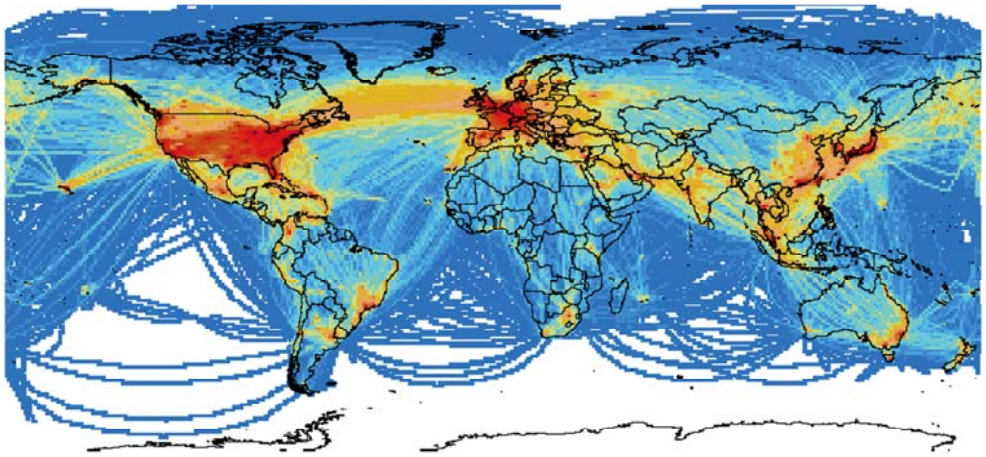
# Statement of need

*" Environmental issues are likely to impose the fundamental limitation on air transportation growth in the 21st century. "*

*U.S. National Science and Technology Council, 1999, National Research Council, 2002*

*British Prime Minister said, "… he would push the EU to curb emissions from aircraft , which by 2030 could represent a quarter of Britain's total contribution to global warming. Britain would argue strongly for aviation to be brought within the next phase of an EU emissions trading scheme. It would set a cap on emissions and require companies increasing output to 'buy' unused capacity from elsewhere."*

*The Guardian, p. 9, September 14, 2004*



*FAA, SAGE Model*

# PARTNER vision

- *A world-class research organization…*
  - *…closely aligned with national and international needs*
  - *…leveraging a broad range of stakeholder capabilities*
  - *…fostering breakthrough technological, operational, policy and workforce advances*
  - *…for the betterment of mobility, economy, national security and the environment*

# PARTNER universities
# 8 schools 80+ students

- *Boise State University (BSU)*
- *Florida International University (FIU)*
- *Massachusetts Institute of Technology (MIT)*
- *Pennsylvania State University (PSU)*
- *Purdue University*
- *Stanford University*
- *University of Central Florida (UCF)*
- *University of Missouri at Rolla (UMR)*

# Sponsors

PARTNER

*FAA Office of Environment and Energy (AEE)*

*NASA Vehicle Systems Program*

Transport Canada

Transports Canada

*$2.8M for FY03/04*

*$3.2M for FY05*

*> $3.5M cost share identified to date*

# Advisory board:
# 29 organizations, 45 members

- *Aerodyne Research Inc. (ARI)*
- *Air Transport Association of America (ATA)*
- *Airports Council International – North America (ACI-NA)*
- *American Institute of Aeronautics and Astronautics (AIAA)*
- *Bell Helicopter Textron*
- *The Boeing Co.*
- *Cessna Aircraft, A Textron Company*
- *Delta Airlines*
- *General Electric Aircraft Engines (GEAE)*
- *Gulfstream Aerospace Corp.*
- *Indiana Dept. of Transportation (INDoT)*
- *Lockheed Martin Aeronautics Co. (LMCO)*
- *Logistics Management Institute (LMI)*
- *Massachusetts Port Authority (Massport)*
- *Metron Aviation*
- *Metropolitan Washington Airport Authority (MWAA)*
- *National Organization to Insure a Sound-controlled Environment (NOISE)*
- *O'Hare Noise Compatibility Commission*
- *Pratt & Whitney (P&W)*
- *Raisbeck Engineering*
- *Rannoch Corp.*
- *Regional Airport Authority of Louisville and Jefferson County (RAA)*
- *Rolls Royce (RR)*
- *San Francisco International Airport/Community Roundtable*
- *Sikorsky Aircraft*
- *United Parcel Service (UPS)*
- *United States Dept. of Transportation (US DoT) Volpe National Transportation Systems Center (TSC)*
- *United States Environmental Protection Agency (US EPA) National Risk Management Research Laboratory (NRMRL)*
- *Wyle Laboratories*

# Research portfolio:
# Three detailed plans
## (Drivers, Goals, Objectives, Challenges, Approaches)

## Noise

**Provide quantitative predictions and qualitative assessments of aviation noise and its impacts, and contribute to mitigation strategies considering all inter-relationships**

## Emissions

**Provide quantitative predictions of aviation emissions & their impacts that contribute to mitigation strategies considering all inter-relationships**

## Interdependencies

**Enable better communication and decision-making in addressing the interdependent environmental effects of aviation by being able to fully assess the benefits and costs of interdependent policies, technologies, operational procedures and market conditions**

# Strategic planning sample: *Interdependencies*

**Overarching Drivers**

*Environmental protection that allows sustained aviation growth*

*Aviation benefits and costs result from a complex system of interdependent environmental effects, technologies, operations, policies and market conditions. There is a need to prioritize tool, metric, technology, operations, policy and R&D activities.*

**Goals**

**Enable better communication and decision-making in addressing the interdependent environmental effects of aviation by being able to fully assess the benefits and costs of interdependent policies, technologies, operational procedures and market conditions**

**Objectives**

*Culture Change - Integrate consideration of interdependencies, risk-based assessments, and distributional socioeconomic effects into regulatory and R&D culture through leadership, communication and engagement.*

*Metrics - Identify and develop the metrics to enable interdependencies and uncertainties to be quantified and articulated*

*Identify Interdependencies - Identify the significant interdependencies within the aviation-environment system*

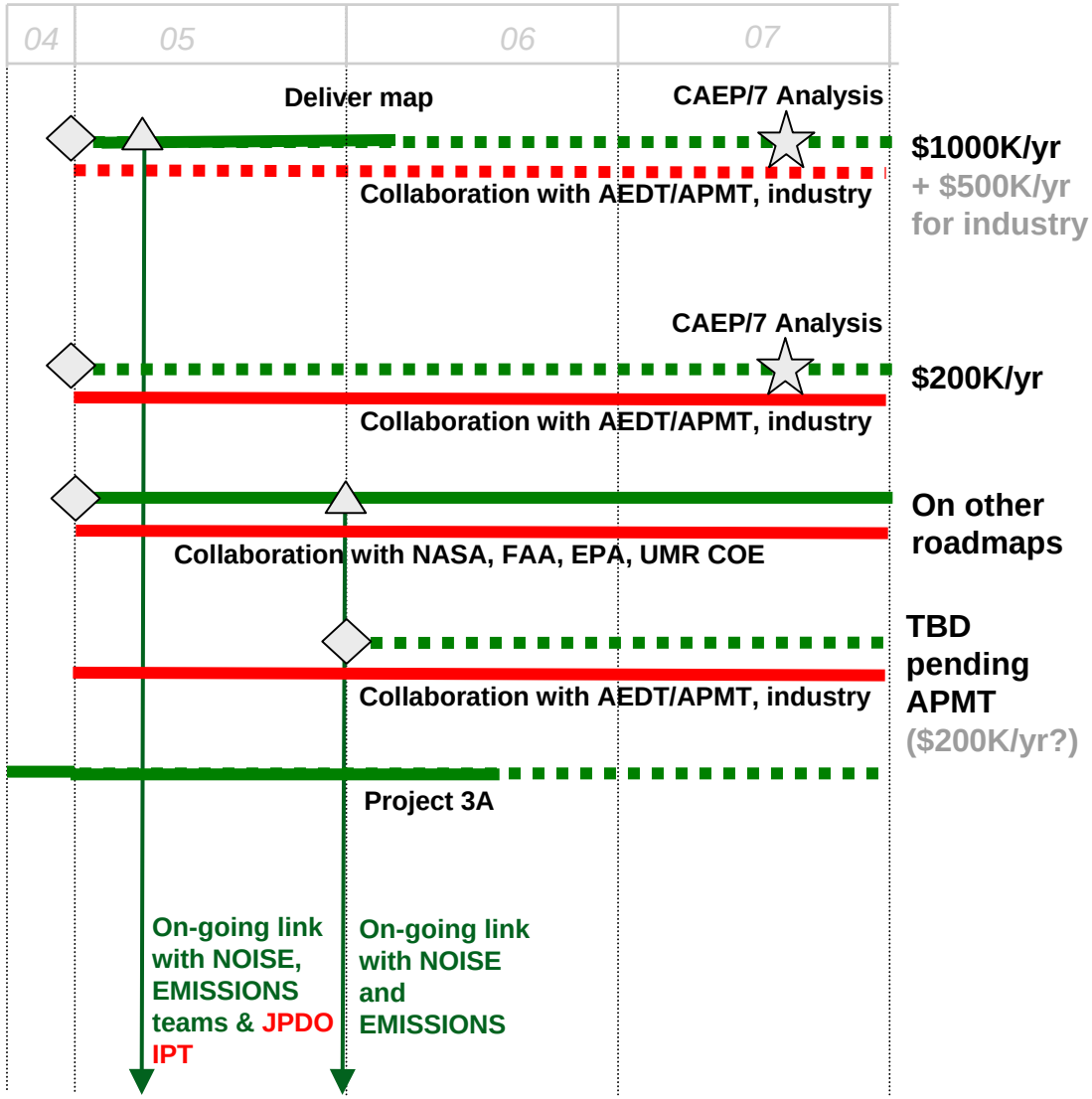
*Tools - Develop tools to enable full assessment of the interdependent effects of policies, technologies, operational procedures and market conditions on health and welfare and the provision of mobility by aviation*

*Significant Examples - Demonstrate the benefits of assessing interdependencies through using the metrics and tools pursuing significant example problems of relevance to the current policy environment*

# Tools roadmap

*83 Points*

- *PARTNER elements within AEDT/APMT Program*
  - *Develop and apply multi-scale modeling for EDS, including assessment, application, forecasting*
  - *Probabilistic assessment (for all of AEDT*
  - *Noise and emission modeling input*
  - *Health and welfare and socioeconomic modeling (Wait on APMT definition, but continue Project 3A work as a feasibility/scoping study*



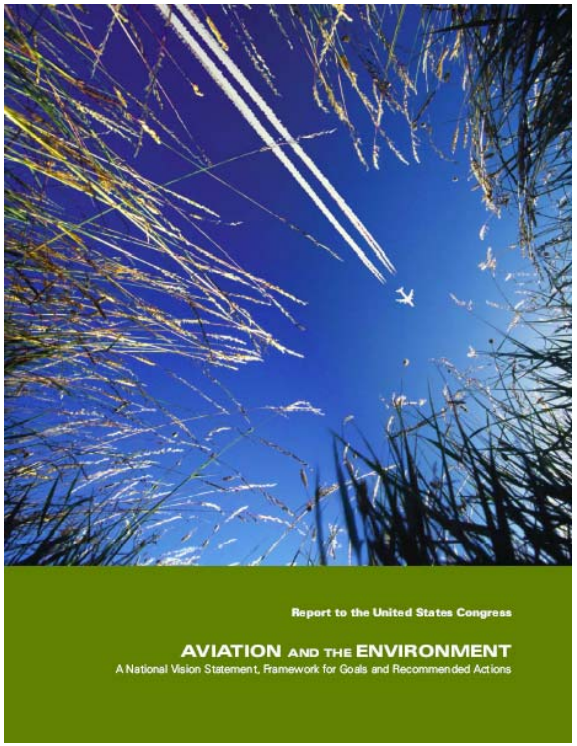

Start
End
Link
Key Milestone
PARTNER (not funded)
PARTNER (funded)
Required collaboration

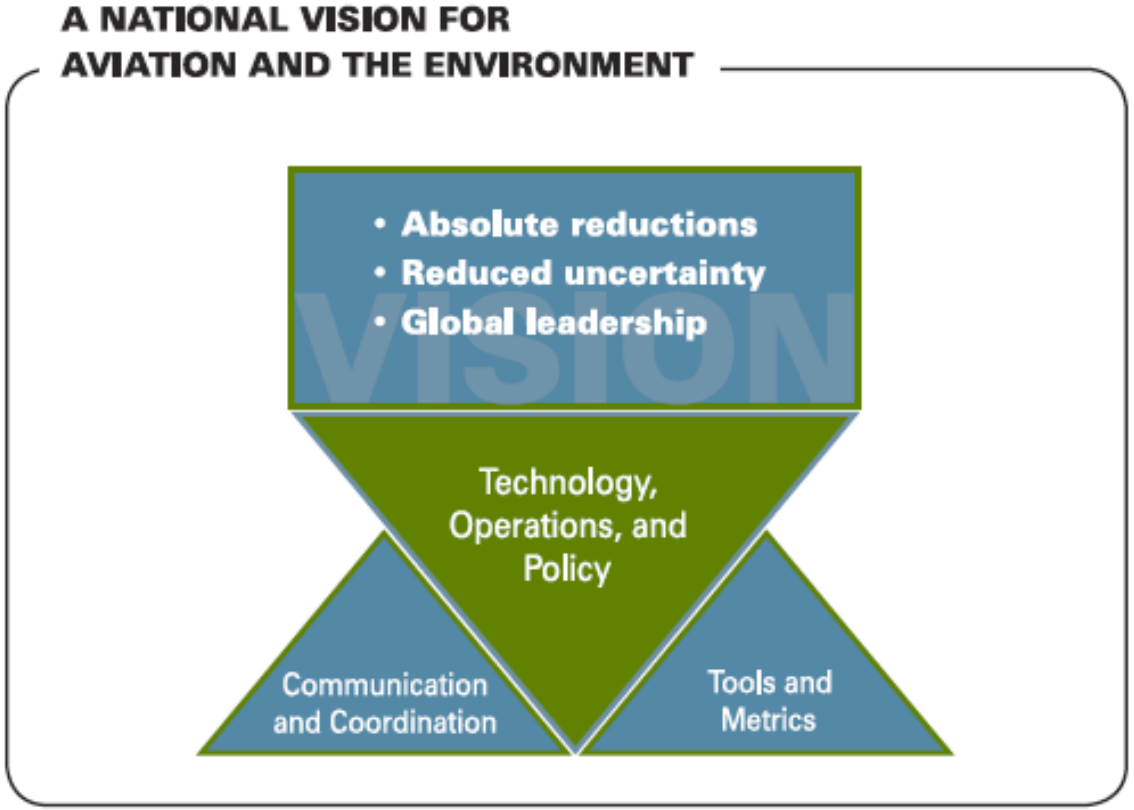
# Recent accomplishments

- *Report to U.S. Congress on Aviation and Environment*
  - *Proposes National Vision for Aviation and Environment, Framework for Goals and Recommended Actions*
- *Multi-Attribute Impact Pathway Analysis*
  - *Contributed first inventories and assessments for PM, climate impacts*
  - *Assessing health and welfare risks of noise, climate, local air quality*
- *Low Frequency Noise Study*
  - *Congressional mandate*
  - *Measurements at active airport*
- *PM Measurements at a North American Airport*
  - *UMR Center of Excellence, UCF, Aerodyne, Volpe, NOAA, NASA, FAA*
  - *Used different methods in plume and near active runway for many aircraft types*
- *Continuous Descent Approach Studies*
  - *Congressional mandate*
  - *Noise and emissions reduction demonstrated in 125 flights of UPS B767's and B757's into Louisville*

# Report to the U.S. Congress

- *60 stakeholders from 38 organizations*
  - *6 months*
  - *1 vision*
  - *3 recommended actions*



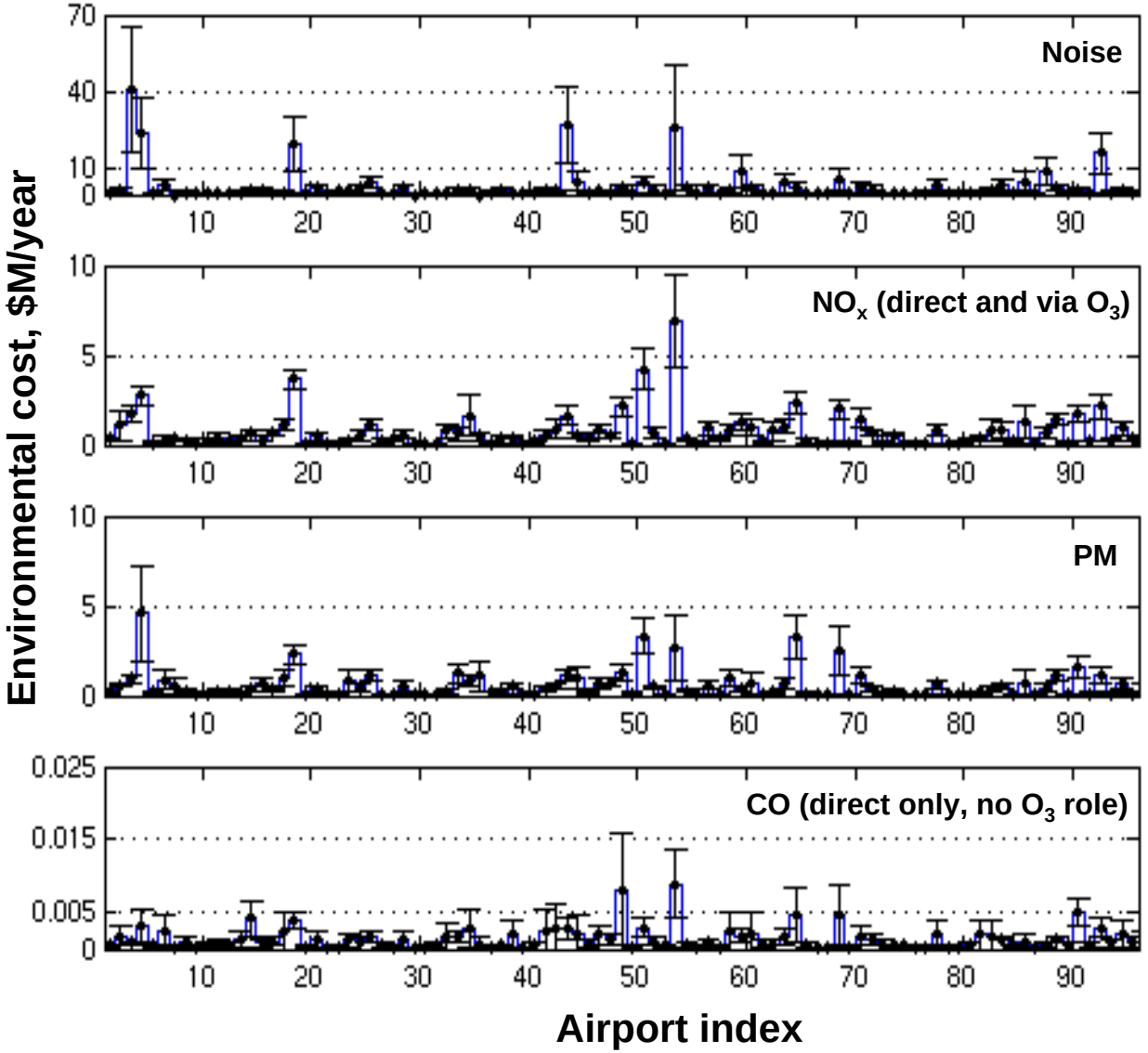
# Report to the U.S. Congress

**A National Vision for Aviation and the Environment:**

*In 2025, significant health and welfare impacts of aviation community noise and local air quality emissions will be reduced in absolute terms, notwithstanding the anticipated growth in aviation. Uncertainties regarding both the contribution of aviation to climate change, and the impacts of aviation particulate matter and hazardous air pollutants, will be reduced to levels that enable appropriate action. Through broad inclusion and sustained commitment among all stakeholders, the US aerospace enterprise will be the global leader in researching, developing and implementing technological, operational and policy initiatives that jointly address mobility and environmental needs.*

# Multi-attribute impact pathway

- *Metrics and tools to estimate uncertain risks*
- *Enables interdependencies to be assessed*
- *Enables prioritization of policy, technology, operational strategies*
- *Noise, air quality, climate*
  - *200+ aircraft types*
  - *96 airports*
  - *All yearly ops,*
  - *Health and welfare risks*

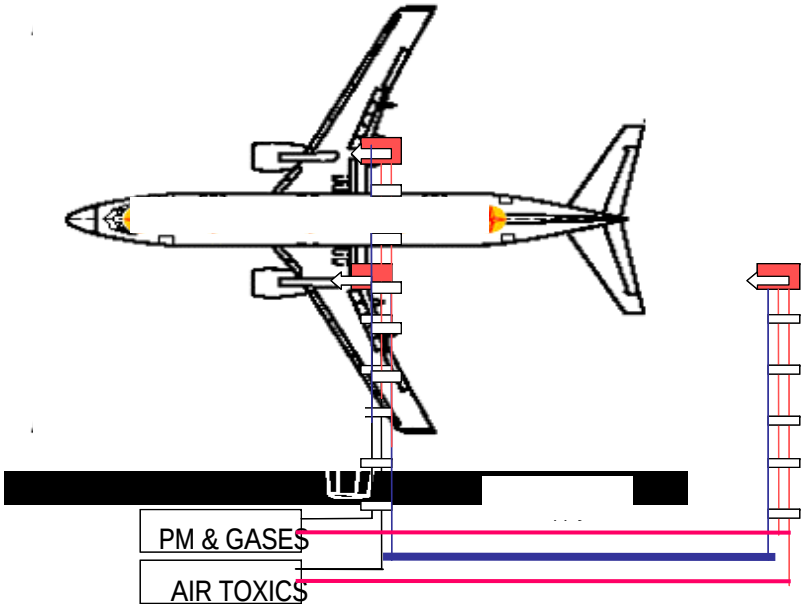


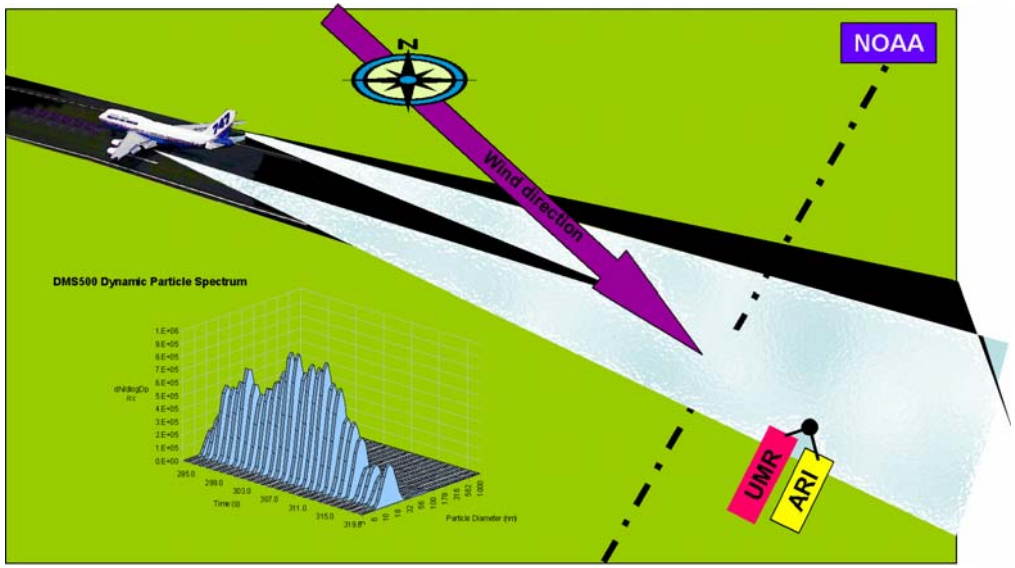
# Low frequency noise study

- *Improved metrics and assessment*
- *Dulles Airport Field Study (Oct. 2004)*
- *Over 500 Thrust Reverser and Sideline Events*
  - *Field microphone arrays*
- *41 hours of residential impact data*
  - *Accelerometers, interior microphones*
  - *Different types of houses*
- *Psycho-acoustic testing*
- *Fleet mix*
  - *GA, RJ's, TP's, B777, B767, B757, B747, B737, A319, A320, A330, A340, DC-9, MD-80*

# Aircraft particulate matter (PM)

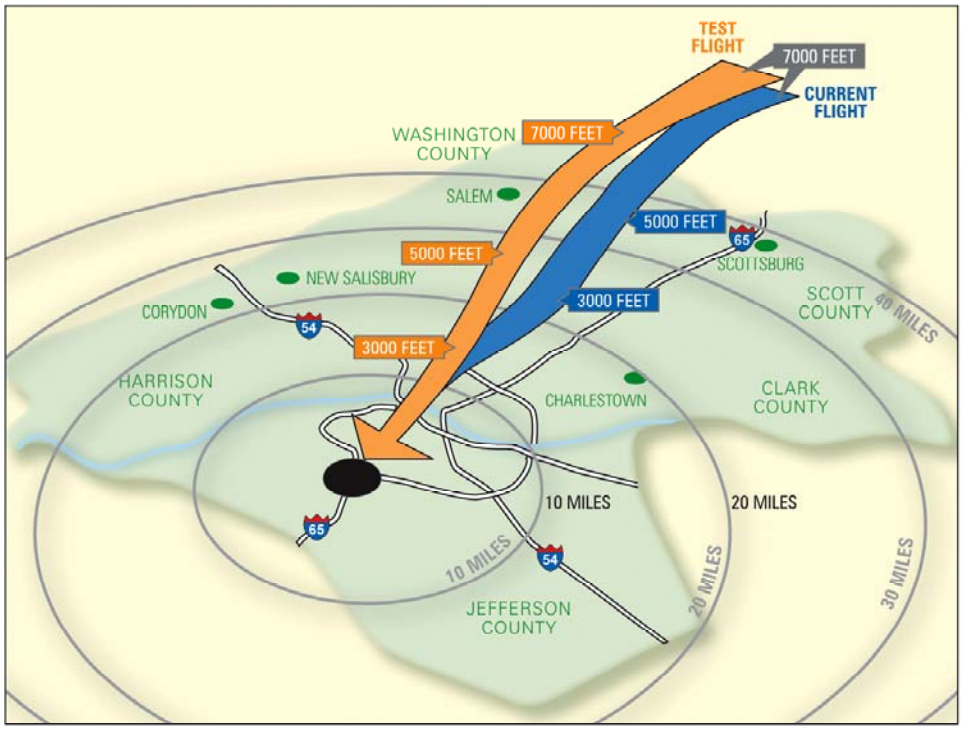
- *Major U.S. Airline*
- *Major U.S. Airport*
- *Measured hundreds of aircraft*
  - *Operational*
  - *After hours*
- *Compared and assessed measurement methods*
- *Modeled PM and precursor behavior*
- *Measured and modeled plume behavior*
- *Used to improve FAA EDMS tool*

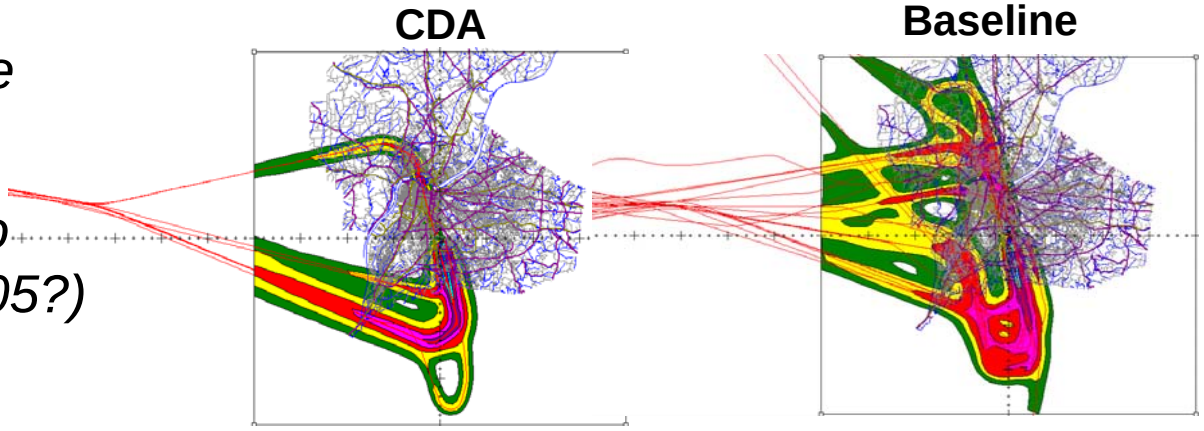


# Continuous descent approach

- *MIT, FAA, NASA, UPS, Louisville Airport*
- *125 UPS aircraft*
- *3-6 dB noise reduction*
- *35% NOx reduction*
- *13-20% CO reduction*
- *11-25% UHC reduction*
- *>120 lbs fuel reduction*
- *2-3 min. flight time reduction*
- *Rapid transition to application (mid '05?)*



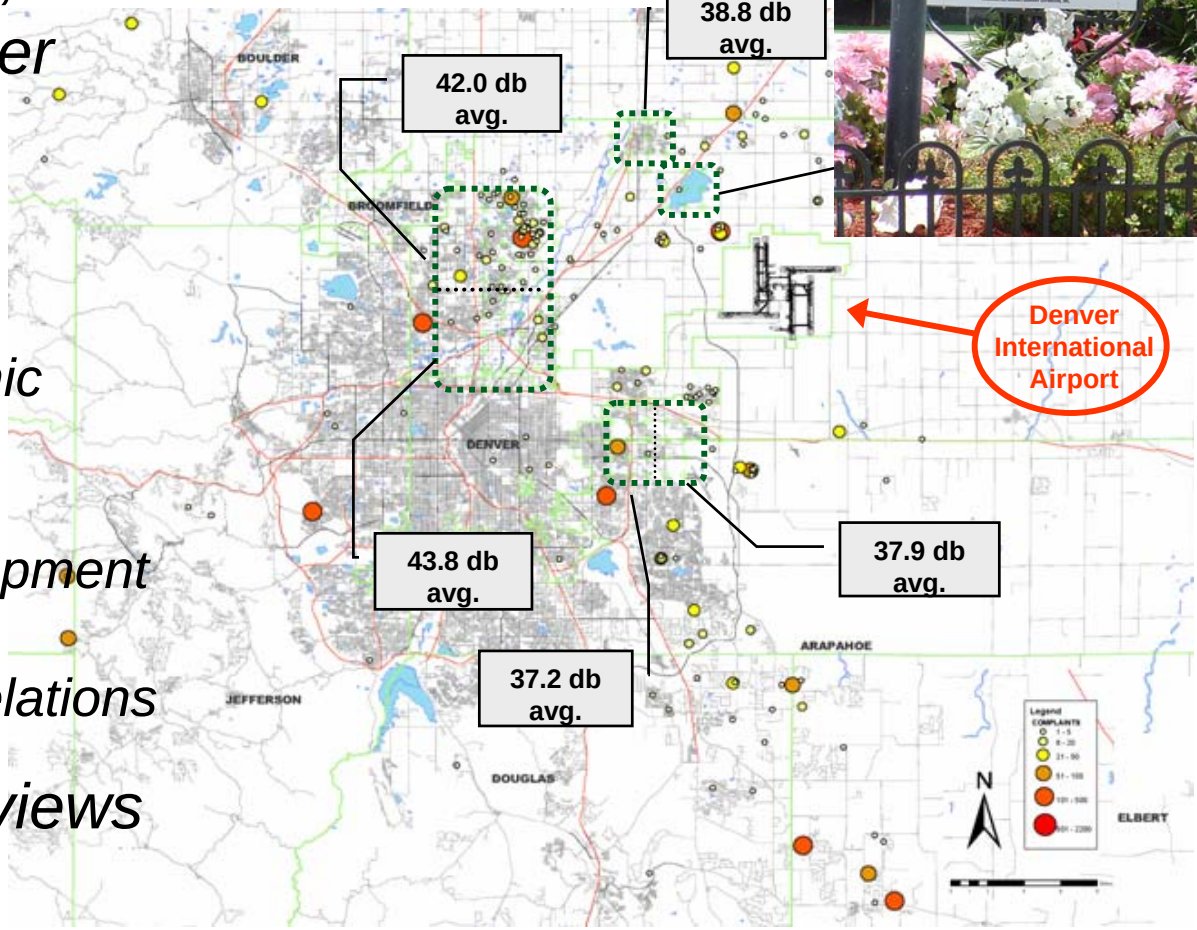



# Other research activities

- *Airport encroachment*
  - *Dynamics of land use, noise and local development*
- *Supersonic flight over land*
  - *Collaborating in large NASA-industry led effort focused on business jets*
- *Environmental design space*
  - *Component of large tool development effort within FAA to enable interdependencies to be assessed*
- *NoiseQuest*
  - *Designing web-based communication tools to better inform the public about aircraft noise*

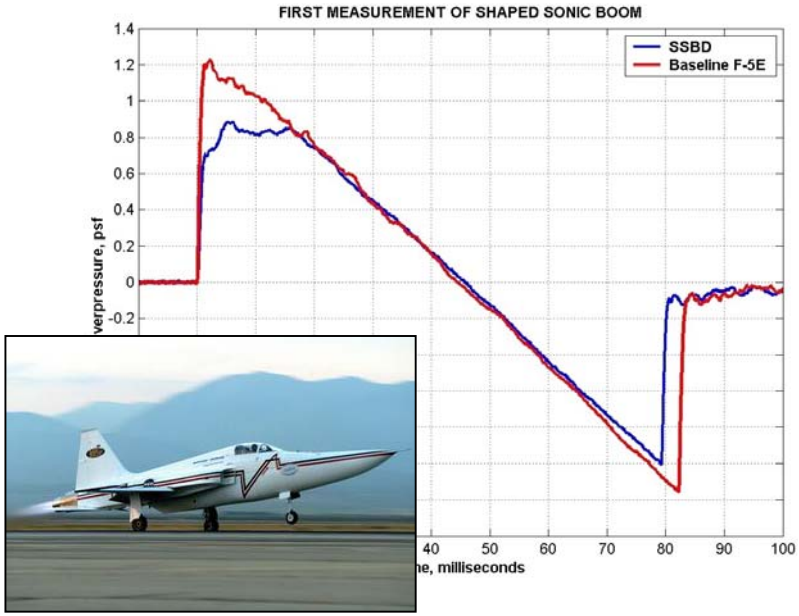
# Airport encroachment

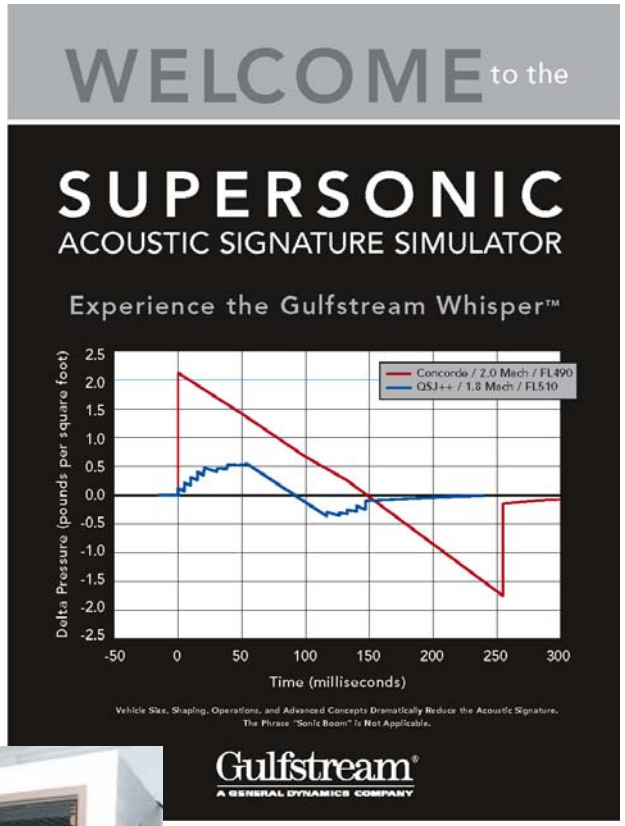
- *What are the dynamics of encroachment?*
- *Ft. Lauderdale, Sanford, Denver International*
- *Time histories*
  - *Complaints*
  - *Local economic development*
  - *Land use*
  - *Airport development*
  - *Noise levels*
  - *Community relations*
- *Personal interviews*




# Supersonic over land

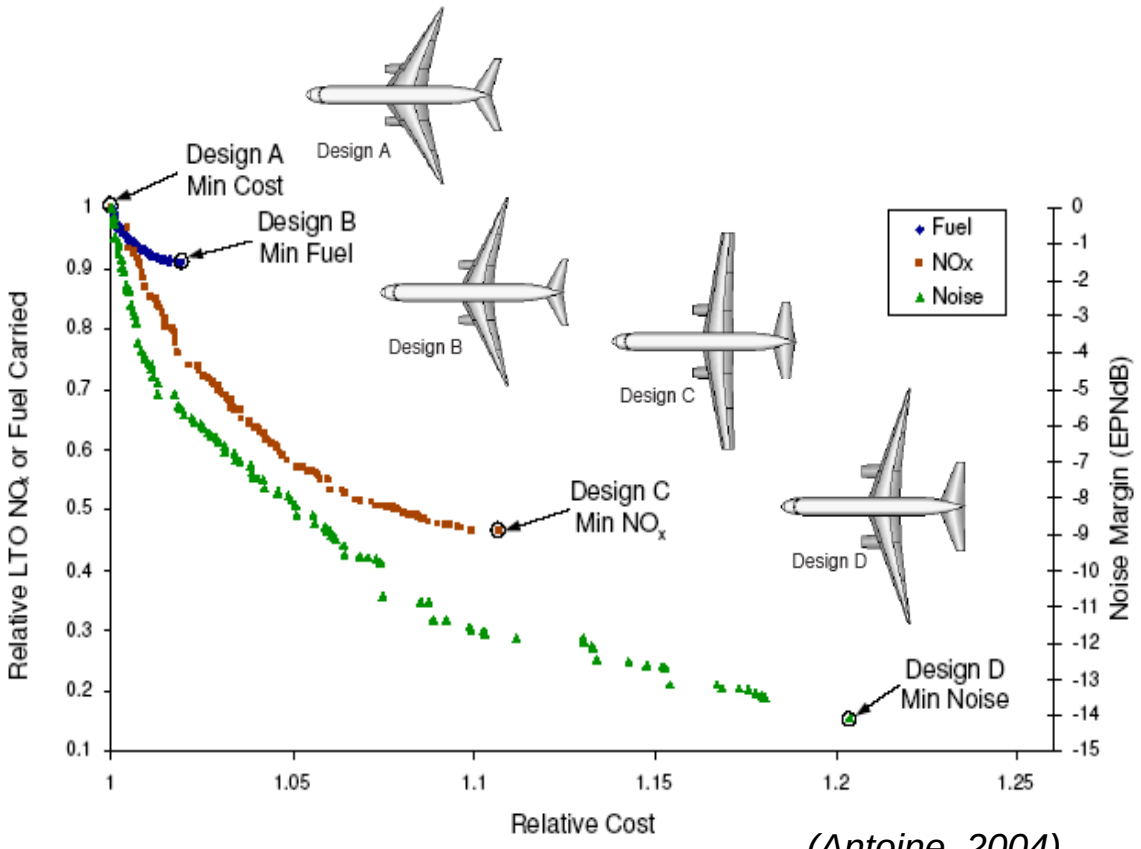
- *Shaped boom waveforms*
  - *What levels/waveforms are acceptable?*
  - *Do low annoyance waveforms remain low annoyance after propagating through atmospheric turbulence, weather?*
  - *How do we design and operate SSJs so the levels are acceptable?*




# Environmental design space

- *Component of new FAA/NASA AEDT & APMT tool suite*
- *Future aircraft*
  - *Performance?*
  - *Cost?*
  - *Environmental Impact?*
- *How will designs be shaped by*
  - *New technology*
  - *Demand*
  - *Policies*
- *Policies and market scenarios*
  - *Cast as objectives and constraints for*
  - *Multi-disciplinary design and optimization problem*




*(Antoine, 2004)*

# Interfaces and communications (last 3 months only shown)

- *External*
  - *NRC APMT Workshop presentation*
  - *TRB Annual meeting presentation on PM Inventory work*
  - *US Airline regarding derate analysis*
  - *CAEP Joint WG 1/3 Meeting in Savannah*
  - *Silent Aircraft Initiative Meetings*
  - *Briefing on climate work to RR Environmental Advisory Board members*
  - *Briefing on climate work to Review Chair for IPCC 4th Assessment*
  - *ASME paper on volatile PM methodology*
  - *ASME paper on soot evolution in gas turbine engines*
  - *MIT Lateral Alignment in Complex Systems Working Group*
  - *Quotes and misquotes in the popular press (ANR, AMC, CSM)*
- *Within PARTNER*
  - *Telecons with Boeing, NASA and Aerodyne on c*
  - *UMR PM COE*
  - *Stanford/NASA GRC EDS Grant*
  - *GaTech/MIT EDS planning meeting (Dec. 23)*
  - *JPDO Environment IPT meeting (Jan 27-28)*
  - *FAA IPT charter calibration meeting (Feb. 11)*
  - *GaTech/MIT EDS Kick-off meeting (Feb 22)*

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TIFF (LZW) decompressor
are needed to see this picture.

- *External*
  - *International activities under CAEP/WG1/SSTG*
  - *Super 10 Alliance*
  - *July 2005 International Sonic Boom Forum, State College, PA: www.outreach.psu.edu/c&i/isna17*
- *Within PARTNER*
  - *Project 8 is in concert with Project 2 (metrics)*
  - *In the future, Project 8 will likely be using outcomes of Project 1 (low frequency noise) regarding rattle and annoyance.*

**External**

- *Presentation at the Palm Springs "Roa 20th" Meeting on Airport Noise and Emissions, organized by UC, Berkeley*

**Within PARTNER**

- *Interation with NASA and Vic Sparrow, Penn State, on human response part c Project 8, Sonic Boom*
  - *Interaction with Aviation Technolog Students at Purdue, Projects 6 and 10*

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- *External*
  - *Presentations to: Airports Council International-North America; Oakland Airport; Denver Airport; ECAC PLANO Workshop; Technical University in Munich; International Airport Noise Symposium; ATAG Environmental Summit.*
  - *Papers being prepared for AIAA ATIO Forum; NOISE-CON; several refereed journals.*
  - *Flight test report*

*Within PARTNER*

- *Advisory Board Meetings, PARTNER UCF/MMU International Workshop*

- *External*
  - *Presentations:*
    - *APEX Conference, DOD SERDP/ESTCP Berkeley ITS Conference*
  - *Other groups:*
    - *CARB, DOD – JSF, H1 helicopter*
- *Within PARTNER*
  - **Project 2 - Measurement, Metrics and Health Effects of Noise**
  - **Project 3 - Valuation & Tradeoffs of Policy Options**

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# Summary

- *Critical needs exist in aviation & environment*
- *Strong team (160 people and growing)*
- *18 months of operation*
- *Some world-class contributions*
- *Areas for improvement*
  - *Collaboration and synergy: common project reports and proposals*
  - *Alignment with national and international needs: strategic plan*
- *Fantastic support from FAA, NASA, TC and Advisory Board members*
- *Poised to become the forum for aviation and the environment*